HW 16 Pressure

1. While exploring a sunken ocean liner the absolute pressure on the robot observation submarine at the level of the ship is measured to be 413 atmospheres. The density of seawater is 1025 kg/m^3.

(a) Calculate the gauge pressure p_g on the sunken ocean liner.

413 atm - 1 atm = $\boxed{412atm}$

Gauge pressure is absolute pressure minus atmospheric pressure. Absolute pressure is the pressure measured against the pressure of a vacuum.

(b) Calculate the depth D of the sunken ocean liner.

$$p_{gauge} = \rho g h$$

$$412atm(101,000\frac{Pa}{atm}) = (1025kg/m^3)(9.8m/s^2)(D)$$

$$D = \boxed{4142.56m}$$

(c) Calculate the magnitude F of the force due to the water on a viewing port of the submarine at this depth if the viewing port has a surface area of 0.0100 m^2.

$$F = ma$$

$$F = (\rho v)a = (1025kg/m^3)(0.001m^2)(4142.56m)(9.8m/s^2)$$

$$F = \boxed{416,120N}$$

Suppose that the ocean liner was at rest at the surface of the ocean before it started to sink. Once the liner began to sink the resistance of the seawater caused the sinking ocean liner to reach a terminal velocity of 10.0 m/s after falling for 30.0 s.

(d) Determine the magnitude a of the average acceleration of the ocean liner during the first thirty seconds of its descent.

$$\frac{10m/s - 0m/s}{30sec} = \boxed{\frac{1}{3}m/s^2}$$

(e) Assuming the acceleration was constant, calculate the distance d below the surface at which the ocean liner reached this terminal velocity.

$$\triangle x = v_o t = \frac{1}{2}at^2$$

$$\triangle x = \frac{1}{2}(\frac{1}{3}m/s^2)(30sec)^2$$

$$\triangle x = \boxed{150m}$$

(f) Calculate the total time t it took for the ocean liner to sink from the surface to the bottom of the ocean.

From 0 to 150 meters, it took 30 seconds.

From 150 to 4142.56 meters, it will take $\frac{4142.56m - 150m}{10m/s}$ = $\boxed{429.26m}$

2. A 0.30 kg ball in a cup of negligible mass is attached to a block of mass M that is on a table. A string passing over a light pulley connects the block to a 2.5 kg object, as shown. The system is released from rest, the block accelerates to the right, and after moving 0.95 m the block collides with a bumper near the end of the table. The ball continues to move and lands on the floor at a position 2.4 m below and 1.8 m horizontally from where it leaves the cup. Assume all friction is negligible.

(a) Calculate the speed of the ball just after the block hits the bumper and the ball leaves the cup.

$$\triangle x = v_o t = \frac{1}{2}at^2$$

$$-2.4m = \frac{1}{2}(-9.8m/s^2)t^2$$

$$t = 0.49sec$$

$$\frac{1.8m}{0.49sec} = \boxed{3.68m/s}$$

(b) Calculate the magnitude of the acceleration of the block as it moves across the table.

$$\frac{3.68m/s - 0m/s}{0.49sec} = \boxed{7.1m/s^2}$$

(c) Calculate the mass M of the block.

$$\sum F = ma$$

$$T = (M)a$$

$$T = (2.5kg)(9.8m/s^2) = 24.5N$$

$$Ma = 24.5N$$

$$M(7.1m/s^2) = 24.5N$$

M = $\boxed{3.45kg}$

(d) If the mass of the ball is increased, the horizontal distance it travels before hitting the floor will decrease. Explain why this will happen.

If the mass of the ball increases, then the acceleration of the ball and the mass M decreases. This means that the horizontal velocity of the ball decreases, thereby decreasing it's horizontal displacement.